

Introduction to Concepts ‘Genomics of Disease in Wildlife’

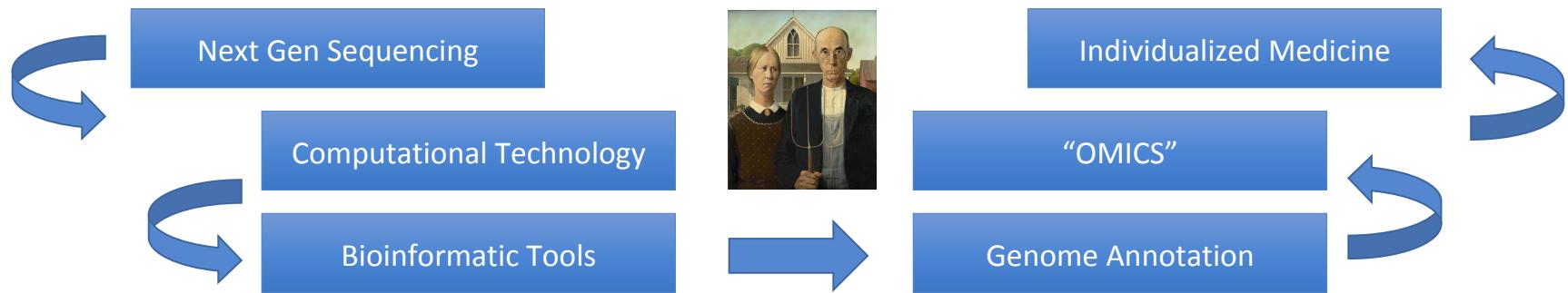
Monday, June 3 GDW 2019

Colorado State University

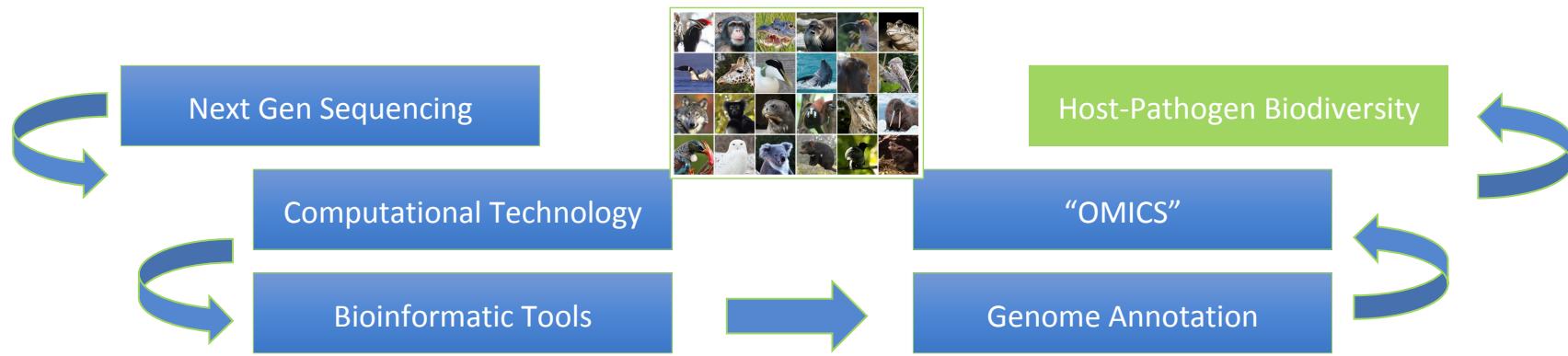
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Biomedicine Drives Next Generation DNA Sequence Technology



Wildlife Biodiversity Provides Nature's Experiment



Biological Diversity: The variability among organisms, including the variability within and between individuals, populations, species and ecosystems.

BioGenomic Diversity: The **DNA** variability among organisms, including the variability within and between individuals, populations, species and ecosystems.



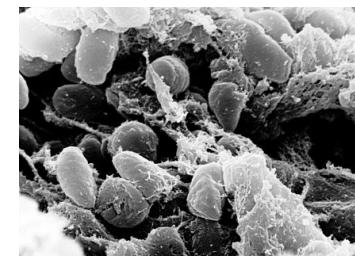
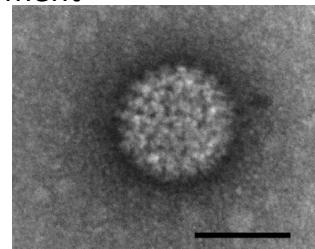
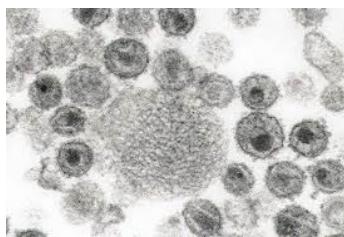
Emergence of Disease in Wild Species: Why Bother?

- Why spend precious research dollars on wildlife disease?
 - Zoonotic pathogens are responsible for ~58% human disease
 - Pathogens are opportunists and jump between wild, managed or domesticated species
- Major impediments for research success
 - Monitoring for disease in wildlife in natural settings expensive, and outbreaks are unpredictable.
 - Pathogen outbreaks often undetected until noticeable morbidity (rate of incidence) or mortality (death)
- Major advances essentially limitless using wildlife biodiversity
 - Selective filter for species fitness-captured in DNA sequence over time and space of survivors.
 - **Natural** systems to model disease emergence, transmission, persistence, quiescence, eradication.
 - Genomic methods identify the molecular basis of the evolutionary arms race between host and pathogen.
- Biodiversity and biomedicine: Symbiosis through Genomics
 - Are lessons to be learned from wildlife that can be applied to **human** disease outbreaks?
 - Are lessons to be learned from humans that can be applied to **wildlife** disease outbreaks?



DNA Sequencing of Pathogens

- Genome organization, structure and function
- Estimation of pattern and rate of mutation within each pathogen gene
- Estimation of genetic diversity within the pathogen
- Identification of emergent strain
- Geographic and evolutionary origin of emergent strain(s)
- Patterns of global transmission
- Co-evolution and adaptation
- Selection
- Fitness traits-replication rate, transmissibility, immune recognition
- Intra-host diversification and horizontal gene transfer among strains
- Vaccine and drug therapy development



DNA Sequencing of Host Species

- Genome structure, content, function, evolution
- Evolutionary history of species
- Population structure and phylogeography
- Historic and ongoing patterns of migration
- Genetic diversity
- Inbreeding
- Domestication
- Hybridization
- Endangered or relic species, subspecies and populations
- Identification of genes involved in disease resistance and progression
- Predictive effects of pathogen emergence in naïve host populations



Day 1: How to Select NGS Data in Experimental Design

- Essential hypothesis-driven design will optimize NGS data inferences
- Establish clear objectives
- Survey existing genomic resources
- Estimate sample size necessary to achieve objectives
- Establish a realistic collection strategy:
 - Disease event, timeline,
 - Patterns of transmission and dissemination,
 - Host specificity,
 - Opportunistic, constant surveillance
 - Wild or managed populations
- Assess availability, quantity, and quality of biological specimens
- Identify computational resources to analyze large datasets
- Establish a genomic workflow for data assessment, analyses and interpretation
- Establish a realistic budget

